Link to the final version: https://doi.org/10.1111/sms.13566

TITLE PAGE

Title

Associations of 24-h activity composition with adiposity and cardiorespiratory fitness: the PregnActive Project.

Running head

24-h activity composition during pregnancy.

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ABSTRACT

Aim

This study examined the associations between activity behaviors composition (sleep, sedentary time, light and moderate-to-vigorous physical activity) with adiposity and cardiorespiratory fitness, and how isotemporal reallocations of time between activity behaviors are associated with differences in adiposity and cardiorespiratory fitness.

Methods

A cross-sectional study was conducted in 130 women during midpregnancy. Activity behaviors, conceptualized as a 24-hour composition, were objectively assessed by multi-sensor monitors. Skinfold thickness, fat mass index, and body mass index were calculated as indicators of adiposity. Cardiorespiratory fitness was assessed using a 6-minute walk test. Log-ratio multiple linear regression models and compositional isotemporal substitutions were used to analyze the associations and estimated differences in outcomes.

Results

The activity composition was significantly associated with adiposity indicators (all $p<0.001$) and cardiorespiratory fitness (p values from 0.025 to <0.001) during midpregnancy. The isotemporal substitutions were asymmetrical, showing the highest estimated differences in adiposity (8.7%, 0.80 kg/m^2, for fat mass index; 6.0%, 2.65 mm, for the sum of skinfold thickness; and 3.8%, 1.02 kg/m^2, for body mass index) and cardiorespiratory fitness (3.0%, 1.00 mL/kg·min) when 30-minutes of moderate-to-vigorous physical activity was reallocated by sedentary time.

Conclusion

The activity composition was associated with adiposity and the cardiorespiratory fitness levels during midpregnancy, with moderate-to-vigorous physical activity being the leading activity behavior. The most unfavorable differences in adiposity and cardiorespiratory fitness were found when moderate-to-vigorous physical activity was replaced by another behavior, mainly sedentary time, reinforcing the importance of at least maintaining moderate-to-vigorous physical activity during pregnancy.

KEYWORDS

Time-use; physical activity; sedentary time; sleep; physical fitness; adiposity.

1. INTRODUCTION

Lifestyle physical activities have been proposed to be behaviors that may protect against the development of cardiovascular diseases or prevent recurrent cardiovascular events [1]. Especially during pregnancy, lifestyle physical activities have potential benefits to reduce the risk of adverse cardiovascular health outcomes, such as hypertension, and obesity [2,3]. Changes in the maternal body composition occur over a short period of time during pregnancy, usually after the first trimester [4]. The increase of the mother's adiposity is a serious problem because of its association with an elevated risk of pregnancy-related complications, long-term maternal obesity and childhood obesity [5,6]. Cardiorespiratory fitness (CRF) exhibits protective effects on established pregnancies and pregnant women's cardio-metabolic health outcomes, such as insulin sensitivity and glucose and lipid disposal [7]. However, limitations in aerobic work capacity, caused by an increase in the ventilatory response related to the elevated metabolic costs of exercise, result in a decline of CRF levels as pregnancy advances [8].

Previous research has focused on the effect of the time spent in ST or MVPA individually, on adiposity and on CRF, promoting MVPA and discouraging ST among pregnant women [9–12]. Taking into account that activity behaviors are mutually exclusive components of the 24-h day, this time has to be reallocated from another activity behavior, which may have different effect on health outcomes depending on what activity behavior is reallocated.

This 24-h activity behaviors concept is related to the notion that to properly understand the association between daily activities and health, the effect of all activity behaviors should be studied relative to each other rather than in isolation [13,14]. The application of this concept implies that activity behaviors data are treated as compositional data that are composed of mutually exclusive and exhaustive parts of a whole 24-h [13].

To date, only two studies have applied compositional data analysis to assess the association of activity behaviors and adiposity in adults [13,15], and only studies in children have assessed the association of activity behaviors with CRF [14,16]. No studies have applied compositional data analysis to pregnant women.

The aims of this study are (1) to assess the associations between the activity composition and adiposity and CRF during midpregnancy and (2) to investigate how time reallocations between activity behaviors are associated with favorable or unfavorable adiposity and CRF.

2. METHODS

2.1 Participants and procedures

This exploratory cross-sectional study was conducted in 130 healthy pregnant women aged 18-45 years who were recruited from antenatal clinics at Utrera Hospital, and voluntarily gave their written informed consent after being informed of the study aims and protocol. The exclusion criteria were physical illnesses or disabilities that affected their normal daily routine or high-risk pregnancy (i.e., diabetes or hypertension). The study protocol obtained ethical approval from the Medical Research Ethics Committee of the University Hospital Virgen del Rocio (Seville, Spain) in accordance with the Declaration of Helsinki, approval number 2014PI-066. The STROBE guideline items were fulfilled during the course of the study [17].

Coinciding with the second visit to the antenatal clinics, approximately at the 20th gestational week, the sociodemographic characteristics, adiposity, and CRF were assessed.

2.2 Measurements

2.2.1 Sociodemographic characteristics

Age, educational level and employment status were assessed using a self-report questionnaire. The pregnant women were categorized according to having a tertiary or non-tertiary educational level, and active or non-active (unemployed, sick-leave from work and student) employment status.

2.2.2 Adiposity

Anthropometry was measured by the same trained evaluator using a stadiometer to measure height, a bioelectrical impedance analysis (BIA) device (Tanita BC-420, Tanita, Tokyo, Japan) to measure weight and the body composition, and a caliper (Holtain, Crymich, UK) to measure skinfold thickness. The sum of the biceps, triceps, and subscapular skinfold thicknesses, measured to the nearest millimeter on the right-hand side of the body, was used as an indicator of maternal adiposity as previously proposed [5,18]. For comparison with previous studies, body mass index (BMI, kg/m^2) and fat mass index (FMI, kg/m^2) were calculated.

2.2.3 Cardiorespiratory fitness

CRF was assessed using a 6-minute walk test (6MWT), previously used with pregnant women [9,19], through a 45.7-meter rectangular course delimited by cones. Participants were encouraged to walk as far as possible without running or jogging. The same trained instructor explained the protocol, provided a demonstration prior to the start, supervised the test and recorded the distance covered to the nearest 0.1 m. A multimedia explanation is available on the link below: https://upotv.upo.es/video/5936500f238583f9658b464a. The resting heart rate was monitored beat-to-beat after a 5-minute seated rest period using a heart rate monitor (Polar Electro Oy, Kempele, Finland). Maximal oxygen consumption (VO_{2max}, mL/kg·min) was estimated from the 6MWT using the equation reported for healthy adults by Burr et al. [20].

2.2.4 24-h activity behaviors

Free-living activity behaviors were objectively measured using a multi-sensor monitor Sensewear Mini Armband (BodyMedia Inc., Pittsburgh, PA, USA) (SWA), validated in pregnant women [21,22], over a 24-hours during a 9-day period, including at least five weekdays and two weekend days. Participants were told to remove the monitor only for water-based activities, which were recorded in a diary. Only participants who carried the monitor for at least 95% of the day (1368 minutes) were included in the study. Five participants participated in swimming and water aerobics or calisthenics for a maximum of 45 minutes, and the time spent in these activities was added using a constant (6 and 4 METs, respectively) from the Compendium of Physical Activities [23]. In addition, non-wear time from showering and self-care were substituted using a constant (2 METs) from the Compendium. The sleep component represents all sleep occurring between 12 PM and 12 PM. The sleep component did not necessarily describe the overnight sleep duration, and it did incorporate naps taken during day. To minimize immediate reactivities that may have altered their habitual lifestyle, we removed the first and the last day of monitoring from the analysis.

2.3 Statistical analysis

Analysis were performed in R using the *compositions* [24], *robcompositions* [25] and *car* [26] packages. The average daily time spent in free-living activity behaviors (sleep, ST, LPA and MVPA) was conceptualized as part of the daily activity behaviors composition and was expressed as isometric log-ratio (ilr) coordinates [13]. All free-living activity behaviors contain non-zero values. The multi-variate dispersion of the activities was described by a pair-wise variation matrix.

Linear regression models were fitted to investigate the associations between adiposity and CRF as outcome variables, and the activity behaviors' ilr coordinate as explanatory variables. Sociodemographic covariates were also included as explanatory variables. The significance of the explanatory variables was examined by a Wald chi square ANOVA type II test [26]. In all models, non-normally distributed variables (sum of skinfold thickness, FMI, and BMI) were log-transformed. Residuals were tested for normality, linearity, homoscedasticity, and independence.

Compositional isotemporal substitutions were used to examine the difference in the outcome variables when quanta of time (from 5 to 30 minutes) were reallocated from one activity to another, while the remaining activities were kept constant [27]. The above models were used as predictive models for new activity behaviors compositions. First, the model was used to predict an outcome value for a baseline composition (mean composition), and subsequently, the same model was used to predict the outcome for new compositions when quanta of time had been reallocated. The estimated differences in the outcome variable were calculated by subtracting the predicted values of the mean composition from the predicted values of the new composition. The significance of the reallocation was assessed based on 95% CI as previously suggested [16]. Effect sizes (ES) were calculated by dividing the estimated differences by the mean standard deviation of outcome variables as previously suggested [28].

3. RESULTS

The study sample was composed of 130 pregnant women, after excluding 36 participants with incomplete data, and their characteristics and compositional means for their activity behaviors are presented in the Supplemental Table 1. The compositional variation matrix is presented in Supplemental Table 2. The smallest variances were observed for sleep with ST and LPA, and ST with LPA (values ≤ 0.195), indicating the greatest co-dependence between activities.

Multiple linear regression models showed that the activity composition was significantly associated with all adiposity indicators and CRF (Table 1). The predicted outcome values for the mean composition were 44.3 mm for the sum of skinfold thickness, 9.1 kg/m^2 for FMI, 26.9 kg/m^2 for BMI, and 33.8 mL/kg·min for CRF.

Compositional isotemporal substitutions were carried out for adiposity indicators and CRF. The raw estimated differences and 95% CI in adiposity and CRF associated with increments of time reallocations are shown in Supplemental Tables 3 and 4, respectively. For a better interpretation of the results, Tables 2 and 3 show the estimated percentage of difference from the mean composition in predicted adiposity and CRF associated with 15-minute and 30-minute reallocations. The reallocations of time involving MVPA was associated with the largest estimated differences in adiposity and CRF and are plotted in Supplemental Figure 1.

The largest estimated differences found in adiposity were observed for the reallocation of time from MVPA to ST. Among the differences the largest differences were observed for FMI, followed by the sum of skinfold thickness, and BMI, although in a small magnitude. For instance, reallocation of 30-minutes from MVPA to ST was associated with higher adiposity, approximately 8.7% for FMI (0.80 kg/m^2, 95% CI: 0.33 to 1.29, ES: 0.23), 6.0% for the sum of skinfold thickness (2.65 mm, 95% CI: 0.83 to 4.52, ES: 0.21), and 3.8% for BMI (1.02 kg/m^2, 95% CI: 0.42 to 1.64, ES: 0.25) compared with the mean composition. The association showed marked asymmetry, the estimated difference in adiposity associated with the reallocation of time from ST to MVPA was lower than the aforementioned estimated difference in adiposity associated with the reallocation of time from MVPA to ST. For instance, reallocation of 30-minutes from ST to MVPA was associated with a difference of -6.1% for FMI (-0.56 kg/m^2, 95% CI: -0.84 to -0.27, ES: -0.17), -4.2% for the sum of skinfold thickness (-1.88 mm, 95% CI: -

3.00 to -0.73, ES: -0.13), and -2.8% for BMI (-0.76 kg/m^2, 95% CI: -1.14 to -0.36, ES: -0.17).

The largest estimated differences in CRF were observed for the reallocation of time from MVPA to ST or sleep. For instance, the reallocation of 30-minutes was associated with a lower CRF by approximately 4.0% (-1.39 mL/kg·min, 95% CI: -2.00 to -0.78, ES: -0.29, and -1.35 mL/kg·min, 95% CI: -2.08 to -0.62, ES: -0.28, respectively) compared with the mean composition. The association showed a marked asymmetry, the estimated difference in CRF associated with a 30-minute reallocation from ST and sleep to MVPA, 3.0% of the mean composition (1.00 mL/kg·min, 95% CI: 0.58 to 1.41, ES: 0.21, and 0.97 mL/kg·min, 95% CI: 0.42 to 1.52, ES: 0.20, respectively), was lower than the aforementioned estimated difference in CRF associated with the inverse reallocation of time. When the model was additionally adjusted for adiposity, the magnitudes of the estimated differences were lower, especially when the model was adjusted for FMI, or the reallocations implying ST and MVPA when the model was adjusted for BMI.

4. DISCUSION

Application of the novel compositional data analysis approach presented in this study allows for a proper analysis of the influence of activity behaviors as mutually exclusive components of the 24-h day on adiposity and CRF. Pregnant women's activity composition was significantly associated with all of the adiposity indicators and CRF, with MVPA being the activity behavior with the greatest association. Isotemporal substitution models suggested that the most unfavorable differences in adiposity and CRF were when MVPA was replaced by ST. Estimated differences were relatively modest, with standardized effect sizes ranging between 0.2 and 0.3. This result reinforces the importance of at least maintaining MVPA during pregnancy, particularly when taking into account the usual decrease of MVPA levels as pregnancy advances [29]. Consistent with previous compositional isotemporal substitution studies in adults [13,15], the highest predicted differences in adiposity indicators were found when MVPA was reallocated to ST. The estimated differences of the sum of skinfold thickness differed for FMI and BMI, which could be explained by their inherent limitations in differentiating between maternal and fetal contributions for adiposity. BMI showed the lowest estimated differences, which could be explained by BMI accounting for lean mass as well, which may be higher while adiposity may be lower with MVPA [30].

Previous studies on pregnant women have shown how MVPA, such as walking and exercise interventions, is associated with the control of maternal adiposity, lipid biomarkers, and weight gain [10,11], but as our results suggest, the greatest benefits of differences in adiposity were obtained when ST was reallocated to MVPA. The fact that physical activity was associated with a lower adiposity could be explained by the ability of exercise to moderate glucose levels by increasing glucose uptake of skeletal muscle and improving insulin sensitivity [31]. Future interventions aimed at maintaining MVPA levels or reducing ST in favor of MVPA may be effective ways to preserve adiposity levels among pregnant women.

The improvement of CRF by increasing MVPA levels is consistent with a previous compositional data study performed on children [14,16] and an isotemporal non-compositional substitution study performed on the general population [32]. In addition, randomized controlled trials in pregnant women [9,11] have suggested that an increase in MVPA levels may improve pregnant women's CRF, but as our results suggest, the highest benefit on CRF was obtained when ST, instead of others behaviors, was reallocated to MVPA. Although the reallocation of time from sleep to MVPA is associated with a similar difference in CRF, considering the important role of sleep in pregnant women's health and the fact that pregnancy alters sleep patterns [33], it would be inappropriate to propose it when pregnant women do not fulfill sleep recommendations [34]. Reallocating time from MVPA to ST was associated with the most unfavorable differences in CRF. Taking into account that usually ST increases and MVPA decreases along the course of pregnancy [35], our results suggest that interventions aimed to at least maintain MVPA and ST levels, or reduce ST in favor of MVPA, may be recommended to limit the decrease in CRF caused by the progression of pregnancy [8].

The associations of the reallocation of time with adiposity and CRF, consistent with previous compositional data studies [13,16], are asymmetrical. For instance the reallocation of time from MVPA to ST led to larger estimated differences in adiposity and CRF than the reallocation of time from ST to MVPA. This difference could be explained by the relative contribution of the different behaviors to the 24-h period. ST accounted for 42% of the day compared with 22% for LPA or 5% for MVPA; therefore, taking 15 minutes from MVPA or LPA is more relevant than taking 15 minutes from ST. In addition, as previous study suggested [13], increasing adiposity or deconditioning occurs rapidly when activity levels drop, while returning to the previous level requires a larger amount of exercise. Therefore, the results highlight the importance of maintaining the levels of MVPA to preserve adiposity and CRF levels during pregnancy, a period of time along which these outcomes unfavorably change [4,8].

The results of this study reinforce the public message suggesting the development of preventive health strategies that focus on the reduction of ST by increasing moving. The fact that ST is the most prevalent behavior among pregnant women during midpregnancy [36], and increases from pre-pregnancy [35] and also from midpregnancy to later pregnancy (about 30 minutes) [37], supports the importance of strategies aimed at reducing ST among pregnant women. As our results suggest, ST may be reallocated to MVPA to obtain the greatest benefits. However, the increase of MVPA during pregnancy may be difficult due to the increases in basal energy expenditure and the elevated metabolic costs of exercise during pregnancy [8], which explain women's selection of less-demanding activities [38] during pregnancy. Therefore, as our results showed, LPA, which accounts for 80% of the pregnant women's time spent in physical activity [39], may be a good way or a progressive step to reallocate ST, although with lower benefits than those obtained by MVPA. This is an interesting finding because the reallocation involving LPA in others CODA studies did not show this association with health benefits [13,16], and as we aforementioned could be explained with the particular characteristics of pregnant women, which could obtain health benefits replacing ST with LPA.

The contribution of physical activity to maintaining general fitness levels has been shown even when physical activity is only started during pregnancy [40]. Considering that pregnancy is identified as a teachable moment in women's life, in which the attention to both women's and fetus' health increases, this stage of life is thought to offer an ideal opportunity to target interventions introducing behavioral changes [41].

4.1 Strengths

This study is the first to apply the principles of a novel compositional data approach during pregnancy to analyze the influence of activity behaviors relative to each other on pregnant women's adiposity and CRF. The use of a multi-sensor monitor provides an objective and direct estimation of all activity behaviors based on energy expenditure, allowing a precise measure of 24-h activity data. Strict analysis of the data, including only participants who carried the monitor for at least 95% of the entire day (mean wear time of 1421 min/day) and removing the first and last day of monitoring, guaranteed the representativeness of the daily activity measure. Adiposity was assessed according the sum of the biceps, triceps and subscapular skinfold thicknesses, which has been proposed to reasonably estimate maternal fat mass and changes in maternal adipose tissue that are not influenced by fetal growth [5,18]. For comparison with previous studies we also use BIA's FMI and BMI, although we are conscious about their inherent limitations during pregnancy.

4.2 Limitations

This study has several limitations. First, the cross-sectional design precludes the establishment of any causal associations. Future studies should analyze the effects of applying interventions that replace ST with MVPA or LPA, to confirm the causal effects for individuals. The fact that high-risk pregnant women were excluded from the study sample and the use of voluntary participation could have resulted in self-selection bias. Future studies with larger sample sizes are required. Multi-sensor monitors cannot differentiate between body positions, such as standing and ST. Studies that combine multi-sensor monitors with postural monitors would better estimate ST. The use of FMI or BMI has inherent limitations related to the impossibility of differentiating between maternal and fetal contributions or between body fat and lean mass, respectively. A submaximal test was used to estimate VO_{2max} although it has inherent limitations, the 6MWT has an acceptable coefficient of variation compared with direct measures [20]. Future studies using a direct measure of VO_{2max} would improve our design. In addition, the development and validation of a specific equation to estimate VO_{2max} for pregnant women could be recommended for future studies on this population.

5. CONCLUSION

The activity composition was associated with adiposity and CRF levels during midpregnancy, with MVPA being the leading activity behavior. Estimated differences were relatively modest, showing the most unfavorable differences in adiposity and CRF levels when MVPA was replaced mainly by ST. The findings reinforce the importance of at least maintaining MVPA and limiting the time spent in ST during pregnancy.

6. PERSPECTIVE

The findings of the present study might be considered relevant for clinical practice. Our results contribute to a better understanding of the associations between 24-h activity behaviors and health outcomes during pregnancy, providing some novelties to the scientific literature, with the application of the principles of the novel compositional data approach during pregnancy. Previous study suggested the usefulness of promoting MVPA and discouraging ST during pregnancy [42], but studying activity behaviors in isolation may be misleading, even more so when the fulfillment of MVPA recommendations is not necessarily related with a reduction of sedentary time during midpregnancy [29]. Consequently, the reallocation of time from ST to MVPA or LPA, although with lower benefits, could be an efficient way to preserve or improve adiposity and CRF levels at midpregnancy. Moreover, future research is warranted to analyze the effects of interventions reallocating ST to MVPA or LPA during midpregnancy.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge all women for their collaboration. We also acknowledge the antenatal health clinic members from Utrera Hospital involved in the recruitment for their effort and great enthusiasm. The study was funded by Research Group CTS-948 of University Pablo de Olavide, Seville, Spain and European University of Madrid, Cátedra Real Madrid, Spain (funding project number P2017/RM08), this funding included material and equipment for the research. There was no external financial support. M.A.O. is supported by the Departamento de Innovación, Investigación y Universidad del Gobierno de Aragón y el Fondo Europeo de Desarrollo Regional – Programa Operativo FEDER Aragón 2014-2020 “Construyendo Europa desde Aragón” (reference number PUI/2018-336). J.B. is supported by the Spanish Ministry of Education (grant number FPU13/05130) and by the Departamento de Innovación, Investigación y Universidad del Gobierno de Aragón y el Fondo Europeo de Desarrollo Regional – Programa Operativo FEDER Aragón 2014-2020 “Construyendo Europa desde Aragón” (reference number PUI/2018-337).

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Table 1. Associations between activity composition[a] and adiposity and CRF: Results from Wald chi square type II ANOVA tests of linear models.

	Sum Sq	Df	F value	Pr(>F)
Sum of skinfold thickness, mm.†	2.6	3	13.9	0.000
FMI, kg/m^2.†	4.9	3	17.1	0.000
BMI, kg/m^2.†	0.9	3	14.8	0.000
CRF (VO_{2max}), mL/kg·min.	906.6	3	20.3	0.000
CRF (VO_{2max}), mL/kg·min. Additionally adjusted for sum of skinfold thickness.	175.5	3	5.7	0.001
CRF (VO_{2max}), mL/kg·min. Additionally adjusted for FMI.	49.2	3	3.2	0.025
CRF (VO_{2max}), mL/kg·min. Additionally adjusted for BMI.	111.5	3	6.2	0.001

Abbreviations: FMI: fat mass index; BMI: body mass index; CRF: cardiorespiratory fitness; VO2max: maximal oxygen consumption. [a] Activity composition expressed as isometric log-ratios. †Log transformed variable. All models are adjusted for age, educational level and employment status.

Table 2. Estimated percentage of the differences from the mean composition in predicted adiposity associated with 15-minutes and 30-minutes reallocations.

15-minutes reallocation					*30-minutes reallocation*				
Sum of skinfold thickness, mm									
	Sleep	ST	LPA	MVPA		Sleep	ST	LPA	MVPA
Sleep		-0.3	**1.5**	**2.4**	Sleep		-0.6	**3.1**	**5.5**
ST	0.2		**1.8**	**2.7**	ST	0.5		**3.6**	**6.0**
LPA	**-1.4**	**-1.7**		1.0	LPA	**-2.8**	**-3.3**		2.5
MVPA	**-2.0**	**-2.3**	-0.5		MVPA	**-3.8**	**-4.2**	-0.8	
FMI, kg/m²									
	Sleep	ST	LPA	MVPA		Sleep	ST	LPA	MVPA
Sleep		-0.8	**1.7**	**3.1**	Sleep		-1.6	**3.5**	**7.1**
ST	0.8		**2.5**	**3.9**	ST	1.5		**5.0**	**8.7**
LPA	**-1.6**	**-2.4**		1.5	LPA	**-3.1**	**-4.6**		3.8
MVPA	**-2.5**	**-3.3**	-0.9		MVPA	**-4.6**	**-6.1**	-1.3	
BMI, kg/m²									
	Sleep	ST	LPA	MVPA		Sleep	ST	LPA	MVPA
Sleep		-0.5	0.5	1.2	Sleep		-1.1	1.0	**2.7**
ST	0.5		**1.0**	**1.7**	ST	1.1		**2.1**	**3.8**
LPA	-0.5	**-1.0**		0.7	LPA	-0.9	**-2.0**		1.8
MVPA	-0.9	**-1.5**	-0.5		MVPA	-1.7	**-2.8**	-0.7	

Reallocation of 15 and 30 minutes are from the activity in the columns to the activity in the rows. Values are expressed in % of the differences from the mean composition in predicted adiposity. Bold type indicates significant change in outcome variable. Abbreviations: FMI: fat mass index; BMI: body mass index; ST: sedentary time; LPA: light physical activity; MVPA: moderate-to-vigorous physical activity. Analysis adjusted for age, education level, and employment status.

Table 3. Estimated percentage of the differences from the mean composition in predicted CRF associated with 15-minutes and 30-minutes reallocations.

15-minutes reallocation					*30-minutes reallocation*				
CRF, mL/kg·min *									
	Sleep	ST	LPA	MVPA		Sleep	ST	LPA	MVPA
Sleep		0.1	**-0.7**	**-1.8**	Sleep		0.1	**-1.5**	**-4.0**
ST	0.0		**-0.8**	**-1.8**	ST	-0.1		**-1.6**	**-4.1**
LPA	**0.7**	**0.8**		**-1.1**	LPA	**1.4**	**1.5**		**-2.6**
MVPA	**1.5**	**1.6**	0.8		MVPA	**2.9**	**3.0**	1.4	
CRF, mL/kg·min (Additionally adjusted for the sum of skinfold thickness)									
	Sleep	ST	LPA	MVPA		Sleep	ST	LPA	MVPA
Sleep		0.1	-0.3	**-1.0**	Sleep		0.1	-0.6	**-2.2**
ST	0.0		-0.3	**-1.0**	ST	-0.1		-0.7	**-2.3**
LPA	0.3	0.3		-0.7	LPA	0.6	0.7		-1.6
MVPA	**0.8**	**0.9**	0.5		MVPA	**1.6**	**1.7**	0.9	
CRF, mL/kg·min (Additionally adjusted for FMI)									
	Sleep	ST	LPA	MVPA		Sleep	ST	LPA	MVPA
Sleep		-0.2	-0.2	**-0.8**	Sleep		-0.4	-0.4	**-1.7**
ST	0.2		0.0	**-0.6**	ST	0.4		-0.1	**-1.4**
LPA	0.2	0.0		**-0.6**	LPA	0.5	0.1		**-1.3**
MVPA	**0.7**	**0.5**	0.5		MVPA	**1.3**	**0.9**	0.8	
CRF, mL/kg·min (Additionally adjusted for BMI)									
	Sleep	ST	LPA	MVPA		Sleep	ST	LPA	MVPA
Sleep		-0.3	**-0.4**	**-1.0**	Sleep		-0.6	**-0.8**	**-2.3**
ST	0.3		-0.1	**-0.8**	ST	0.6		-0.2	**-1.7**
LPA	**0.4**	0.1		**-0.6**	LPA	**0.8**	0.2		**-1.5**
MVPA	**0.9**	**0.6**	0.5		MVPA	**1.7**	**1.1**	0.9	

Reallocation of 15 and 30 minutes are from the activity in the columns to the activity in the rows. Values are expressed in % of the differences from the mean composition in predicted CRF. Bold type indicates significant change in outcome variable. Abbreviations: CRF: cardiorespiratory fitness; FMI: fat mass index; BMI: body mass index; ST: sedentary time; LPA: light physical activity; MVPA: moderate-to-vigorous physical activity. *Analysis adjusted for age, education level, and employment status.